

## REMARKS

Claims 1 - 3, 5 - 7, 9 and 10 remain active in this application. Claims 4 and 8 have previously been canceled. Non-elected claims 11 - 16 are currently canceled. Amendment of claims 1 and 3 is currently requested. Support for the amendments of the claims is found throughout the application, particularly in Figure 2, and pages 3, 9, 11 and 12 and the Abstract of the specification as originally filed. No new matter has been introduced into the application.

Before discussing the rejections based on prior art, it is respectfully submitted that the finality of the present action is premature. It was pointed out in the previous response that the Examiner had failed to make a *prima facie* demonstration of the propriety of the grounds of rejection asserted in that action and the amendments made in claim 1 (the only amendments presented therein) merely relocated, as a matter of clarity, recitations previously contained therein. Therefore, the amendments made in the previous response cannot have necessitated the new ground of rejection and, moreover, an action should not be made final when the previous action did not include a *prima facie* demonstration of the propriety of the grounds of rejection stated therein. Otherwise, finality precludes an opportunity to Applicant to substantively address the best prior art applied by the Examiner based on results of a search which reflects an adequate understanding of the invention, including its purposes and principles.

In this regard, this is a response to the *sixth* official action on the merits of this application following a requirement for restriction (and Supervisory review is respectfully requested under M.P.E.P. §707.02 for that reason) and it is clear from the record that most, if not all, prior art applied has

been of only marginal relevance and has not addressed the principles, purposes and meritorious effects of the invention since most such grounds of rejection have been withdrawn after the subsequent response and new rejections made with art of similarly marginal relevance and directed to the production of different effects, as is the case in the present action in regard to Shue et al. as will be discussed below. Therefore, the Examiner has had ample opportunity to place the best prior art found in the record prior to the current final rejection and the finality of the rejection is clearly prejudicial in potentially denying the Applicant the opportunity to respond to newly cited prior art by amendment of the claims. Accordingly, withdrawal of the finality of the current action or at least entry and consideration of the merits of the claims as amended by the above-requested amendments is believed to be in order and is respectfully requested.

Claims 1 and 5 have been rejected under 35 U.S.C. §103 as being unpatentable over Colgan et al. in view of Shue et al. (newly cited); claims 2, 3, 6 and 7 have been rejected under 35 U.S.C. §103 as being unpatentable over Colgan et al. in view of Shue et al. and Zhao et al. and claims 9 and 10 have been rejected under 35 U.S.C. §103 as being unpatentable over Colgan et al. in view of Shue et al. and Jain (the reference to Drynan in the discussion thereof is not understood and, in any case, is clearly in error). These grounds of rejection are respectfully traversed, particularly as being moot in view of the amendments requested above.

As discussed in at least the previous response, Colgan et al. is relevant to the present invention only as disclosing the environment of the invention: an integrated circuit having an aluminum wiring level above a copper wiring level. Colgan et al. does not recognize the problem of corrosion of copper by process

materials when forming a tungsten stud for connection between copper and aluminum wiring layers, much less proposing a solution by formation of a barrier liner in a via prior to tungsten deposition. Rather, Colgan et al. addresses the problem of metal migration when copper and aluminum are *in contact with each other* (and not separated by a tungsten stud) and does so by providing "a continuous path for copper and aluminum atoms to move in the interconnect structure" (Abstract, last sentence). Therefore, interposition of any type of barrier in or by use of an interconnect material of another material would prevent operation of Colgan et al. in the intended manner and, hence, any modification of Colgan et al. which would include provision of such a barrier (including the barrier 28a or stud layer 30a of Shue et al.) would be improper under *In re Gordon*, 221 USPQ 1125 (Fed. Circ., 1984), as noted in the previous response.

Shue et al. is not concerned with the metallurgy of conductive layers or their sequence. Materials disclosed as suitable for the different wiring layers (noted at column 7, lines 39 - 53, for the lower conductive level and at column 11, lines 41 - 51, for the upper conductor level) are substantially identical, non-critical and both include both copper and aluminum. Likewise, the reactivity of stud materials with any of the listed suitable conductor materials is not at all considered by Shue et al. since, among the barrier materials listed at column 11, lines 30 - 40, tungsten is included, deposition of which causes the corrosive effects on copper to which the present invention is directed. Further, titanium and titanium nitride are also included and indicated to be preferred in the same passage; titanium being documentably more reactive with copper than tantalum and tantalum nitride or titanium nitride, the former being disclosed as preferred for practice of the present invention.

Rather, Shue et al. is principally concerned with protection of dielectric materials such as low-k dielectrics which are known to adsorb moisture and other materials which may lead to corrosion and damage to a wide variety of materials after the manufacture of the integrated circuit is completed. Therefore, the principal feature of Shue et al. is the passivating purging and degassing of the vias with a plasma process as recited in the penultimate paragraph of claim 1 of Shue et al. The function of the plasma processing step is explicitly recited in claim 25. No direct reference to the barrier layer 28 is seen in the claims.

Therefore, it is clear that Shue et al. is directed to a much different problem than the invention and does not recognize, consider or provide a solution to the problems of corrosion of copper due to use of interconnection materials, such as tungsten, suitable for connecting a lower copper layer to a higher aluminum layer with a small structure. Even if Colgan et al. could be properly modified to answer the recitations of the claims, as discussed above, Shue et al. does not provide evidence of a level of ordinary skill in the art which would lead to an expectation of success in solving the problem of copper corrosion (which Shue et al. clearly does not address in view of the inclusion tungsten and titanium among suitable barrier materials) or otherwise support a conclusion of obviousness of the subject matter claimed.

In this regard, it is significant that while Shue et al. incidentally also includes titanium and titanium nitride with tungsten in the list of suitable barrier materials (and indicates such materials to be preferred), the Examiner has not suggested that Shue et al. anticipates the claimed subject matter, presumably at least because the Examiner correctly recognizes that Shue et al. does not teach or suggest the claimed sequence of copper and aluminum; for which the Examiner

improperly relies upon Colgan et al. as discussed above. Further in this regard, the inclusion of titanium, titanium nitride and tungsten among suitable materials as well as preferring titanium and/or titanium nitride to tantalum and/or tantalum nitride Shue et al. clearly does not consider or provide teachings or suggestions in regard to the desirability of using materials which are non-reactive with copper and thus cannot provide teachings suggestions or evidence of a level of ordinary skill in the art which are relevant to concerns that are central to production of the meritorious effects of the present invention. The same is true of Zhao et al. (and the Examiner does not assert that any barrier structure or materials of a similar sort is taught or suggested by Jain; Jain being applied only in regard to a covering layer recited in dependent claims 9 and 10). By the same token, in preferring titanium and/or titanium nitride to tantalum and/or tantalum nitride (which is preferred for practice of the invention, as clearly indicated by the original disclosure) or other materials of lesser reactivity with copper, Shue et al. tends to teach away from the subject matter recited in the claims as rejected and, particularly, amended as requested above.

While the combination of Colgan et al. and Shue et al., whether or not supplemented by Zhao et al or Jain, has been shown to be improper and that neither reference taken alone answers the claimed subject matter, as determinable on the record of this application, amendment of the claims has been requested to clearly distinguish from the prior art of record in order to expedite the protracted prosecution of this application. Neither reference teaches or suggests a multi-layer liner for a via particularly not one including a first layer of a material having a reactivity with copper "equal to or less than tantalum or tantalum nitride or titanium nitride" and/or a

second layer which is conductive and which "assists in the formation of a stud during deposition of tungsten". These recitations exclude titanium which is documentably more reactive with copper than the materials listed while encompassing suitable materials having properties clearly not taught, suggested or considered by the prior art. Moreover, the prior art applied against the claims contains no suggestion of a second layer which assists in formation of the tungsten stud or, for that matter, any multi-layer liner, regardless of materials for the purpose of avoiding attack of copper by process materials during formation of a connection stud of tungsten.

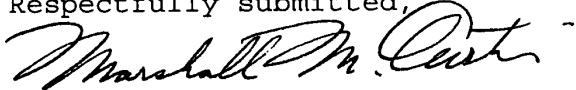
Accordingly, it is respectfully submitted that all of the stated grounds of rejection are clearly in error and unsupported by the references relied upon which as improperly combined, as well, while failing to answer the claimed subject matter or providing evidence of a level of ordinary skill in the art which would support a conclusion of obviousness in regard to any claim. By the same token, the present office action continues to fail to make *prima facie* demonstration of the propriety of any ground of rejection contained therein; further indicating that the finality of the present action is premature and should be withdrawn. Therefore, entry of the above-requested amendments and reconsideration and withdrawal of the rejections based on prior art are respectfully requested.

Since all rejections, objections and requirements contained in the outstanding official action have been fully answered and shown to be in error and/or inapplicable to the present claims, it is respectfully submitted that reconsideration is now in order under the provisions of 37 C.F.R. §1.111(b) and such reconsideration is respectfully requested. Upon reconsideration, it is also respectfully submitted that this application is in condition for allowance and such

action is therefore respectfully requested.

If an extension of time is required for this response to be considered as being timely filed, a conditional petition is hereby made for such extension of time. Please charge any deficiencies in fees and credit any overpayment of fees to Deposit Account No. 09-0458 (International Business Machines Corporation - Fishkill).

Respectfully submitted,



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